Congressional Notification Profile
DE-PS26-02NT41369

UNIVERSITY COAL RESEARCH PROGRAM, INNOVATIVE CONCEPTS PROGRAM
Iowa State University

Background and Technical Information:
Project Title: "Development of a Catalyst/Sorbent for Methane Reforming."

Iowa State University will develop a material that improves the efficiency of making hydrogen from coal and separating carbon dioxide from hydrogen. Specifically, a catalyst and a sorbent for CO_2 separation will be combined into a pellet containing a calcium core encased in a strong, porous shell covered with a nickel catalyst.

Earlier research shows a two-stage process produces catalyst/sorbent pellets suited to hydrogen production. Experiments using a fixed-bed reactor will verify the pellets' effectiveness while other analyses will establish their ultimate absorption capacity. If successful, the project would be well-suited to the Vision 21 concept of using fuel cells, which run on hydrogen, to produce electricity from coal.

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Congressional District: IA 3rd County: Story

Financial Information:

Length of Contract (months): 12
Government Share: $50,000
Total value of contract: $66,006

DOE Funding Breakdown:
Funds: FY 2002 $50,000

PUBLIC ABSTRACT OF RESEARCH SPONSORED BY
U.S. DEPARTMENT OF ENERGY AND IOWA STATE UNIVERSITY *

Abstract

The goal of this project will be the development of a unique material, which can improve the overall efficiency of producing hydrogen from coal. Therefore, the project can make an important contribution to the Vision 21 concept of producing electrical power from coal more efficiently by using fuel cells supplied with hydrogen fuel.

One of the most efficient methods for producing hydrogen from coal makes use of hydrogasification to produce methane, which is then reacted with steam at high temperature to produce hydrogen and carbon dioxide. For maximum efficiency this reaction needs to be conducted in the presence of both a catalyst and a sorbent for the carbon dioxide. The sorbent serves both to drive the reaction and to separate the hydrogen from the carbon dioxide. These principles have been demonstrated previously in the laboratory by using a mixture of commercially available catalyst and a sorbent such as calcium oxide.

The present project will show how the catalyst and sorbent can be combined into a single pellet consisting of a calcium-based core encased in a porous shell impregnated with a nickel catalyst. The project will build on the results of earlier work, which showed that suitable core-in-shell pellets could be made by a two-stage pelletization process followed by calcination. The resulting pellets have cores, which react readily with carbon dioxide and shells, which are porous, strong and inert. The shells appear well suited to serve as a catalyst support.

To prepare the combined catalyst/sorbent, core-in-shell pellets will be prepared as before and then impregnated with a nickel nitrate solution. After drying, the pellets will be heated to decompose the deposited nickel salt and then treated with hydrogen to reduce nickel to a metallic state. The finished pellets will be examined by X-ray diffraction analysis to determine the nickel species present and their concentration and by scanning electron microscopy to determine the radial distribution of nickel in a pellet cross-section. The overall concentration of nickel will be determined by acid leaching and analysis of the leachate by atomic absorption spectrophotometry.

The catalytic activity and sorbent characteristics of the pellets will be determined by employing both thermogravimetric analysis and a fixed-bed reactor. In both cases a mixture of steam and methane will have an opportunity to react in the presence of the catalyst/sorbent. Thermogravimetric analysis will provide an indication of reaction rate and ultimate absorption capacity of the pellets, while experiments conducted with the fixed bed reactor will demonstrate the overall effectiveness of the catalyst/sorbent.

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